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(54) METHOD OF AND APPARATUS FOR PRODUCING A SHAPED MATERIAL MADE OF WOOD AND THERMOPLASTIC PLASTICS

(71) I, HELMUT BRAUNING, a German Citizen, of 10a Gustav-Hugo-Strasse, 453 Ibbenbüren, Germany, do hereby declare the invention, for which I pray that a patent may be granted to me, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to a method of and apparatus for producing a shaped material made of wood and a thermoplastic plastics, as well as to the product produced by the method.

The present method serves to provide a rigid, wood-like material which may be produced at low cost in view of the relatively low price of wood. In such materials, among other things, care has to be taken that such materials do not swell under the influence of moisture and that glues and lacquers or paints adhere thereto.

According to one aspect of the present invention there is provided a method of producing a shaped material made of wood and a thermoplastic plastics, wherein a mixture of finely divided wood having an average particle size of not more than 3 mm. and finely divided thermoplastic plastics material having an average particle size of from 0.02 to 10 mm., in a ratio of from 50 to 90 percent by weight of wood and from 50 to 10 percent by weight of plastics material is heated up to a temperature at which the plastics material is present in a plastic to highly viscous state, the mixture then being subjected to compression followed by decompression or expansion, with removal, at least during the decompression phase of a gas-water mixture evolved as a result of the heating of the wood, and wherein the mixture of wood and plastics is then introduced into an extrusion die and extruded.

The material produced by the present method may be coated or covered with a fused plastics material such that a protected product having a satisfactory aesthetic appearance can be produced. To this end, it is necessary to dry the wood employed to such a degree that all traces of the disadvantageous water are removed while the material nevertheless retains its solid consistency.

Wood of any kind may be used in carrying out the present method, the wood being, for example, in the form of chips, fibres or wood flour, such as are produced by-products in various wood processing methods.

The term "finely divided thermoplastic plastics material" is used in the present Specification to mean a plastics in the form of particles having a particle size in th range of from 0.02 to 10 millimetres. It is desirable to adapt the particle size of the plastics material to the particle size of th wood, i.e. to mix wood particles having a particle size at the upper end of the above given size range with particles of plastics material having a particle size at the upper end of their given size range, or *vice versa*.

The present method is performed at a temperature at which the plastics material employed is present in a plastic to highly viscous state, the temperature — i.e. the extrusion temperature — being within the general range of from 70 to 220°C., preferably within the range of from 180 to 220°C.

The compression and decompression is preferably performed using an extruder, using conventional pressures, in the range of 0.1 to 150 kp./cm.².

A partial vacuum is preferably used to effect degasifying, which, if possible, is only effected after an intimate mixing of the wood and plastics has occurred.

It is preferred to use a finely divided rigid polyvinyl chloride, because this material is available at low cost — even as a waste material — and has good thermoplas-

tic properties, a ratio of 60 percent by weight of wood and 40 percent by weight of PVC being preferably employed. The particles which may be in the form of chips should have approximately the same size, and have a dimension of from 0.05 to 3 millimetres. Pre-dried beech-wood in the shape of chips is particularly suitable as the wood.

Particularly favourable mixing conditions, which overcome the poor thermal conductivity of the wood, are obtained if the initially introduced mixed material is rapidly heated, i.e. by about 100°C. per minute, to a temperature of 190°C. ± 20°C., and this temperature is maintained up to the extrusion die. This rapid heating is in contrast with a conventional method commonly used in extruders, namely to slowly heat the mixed material during the advance thereof.

Optimum degasifying and an absence of pores in the mixed material are obtained by first compressing the heated mixture, thereafter passing it through a zone of high pressure, and subsequently decompressing it by simultaneously applying a vacuum thereto and removing the resulting gas-water mixture. Thereafter, the material can be extruded through the extrusion die, and the resulting extrusion may exit to the atmosphere, where it cools and releases residual gas through its surface. It has been found to be advantageous to operate at a reduced pressure of from −0.5 to −0.9 kp./cm.^{2}, whereby, depending upon the wood and plastics and the shaping of the moulded material, a more or less high degree of degasifying and, thus, an improved structure of the extruded material is obtained. In order to achieve a structure of particularly high density, it has been found to be advantageous to effect the decompression or expansion only immediately prior to the introduction into the extrusion die.

In order to smooth the surface of the extruded material while simultaneously cooling such surface, it has been found to be advantageous to press the extruded material in discrete lengths, using press faces which are cooled.

The product obtained in this manner has a dense structure, a smooth surface and a slightly porous consistency and is particularly suitable for being coated with a mass of plastics material.

Advantageously, the extruded material which has left the extrusion die may be covered by drawing the material through a heated chamber to which a thermoplastic plastics similar to that used to form the original mixture is pressure fed so as to mould and fuse a cover layer around the extruded material within the chamber.

The heated chamber may comprise conventional extrusion dies.

The thermoplastic covering material may be of similar chemical nature to that in the material being coated and may be a coloured or non-coloured thermoplastic plastics material, such as a rigid or plasticised PVC. It is important that the surface of the covering or sheath is fusably bonded to the substrate material and rigid or plasticised polyvinyl chloride is especially useful for this purpose.

The hot extruded material leaving the extruder or moulding tool may be coated with a thermoplastic adhesive, and a coating film may be bonded by pressing it against the extruded material. An advantage of this mode of coating is that the heat of the extruded material may be utilized to melt a thermoplastic adhesive and the pressing of the film can be performed in the subsequent steps of the process without requiring any further apparatus.

A particularly simple, but relatively expensive manner of coating is achieved by feeding to the extruded material a film which is already coated with a thermoplastic adhesive. This kind of bonding eliminates the requirement for an additional apparatus for applying the thermoplastic adhesive.

If it is desired to provide the coated material with a decoration or ornamentation, it is proposed to shape the extruded material during the pressing step and/or during an additional pass through a press. It is also possible to form not only successive ornamental designs, but also patterns which repeat each other again and again. For example, it is also possible to produce a continuous bar or board the surface of which is grained like wood and which carries raised inscriptions.

According to another aspect of the present invention there is provided apparatus for producing a shaped material made of wood and a thermoplastic plastics, comprising a screw-type extruder and means for heating it, the screw-type extruder having a barrel within which is located a screw providing at least the following zones, as seen in the intended direction of travel of material therethrough:

(a) a zone comprising a dual lead screw, the volume between successive pitches of which decreases in said direction;

(b) a zone comprising a shaft portion without any screw leads, but having such a diameter that material pressed by the upstream leads is compressed between the inside of the barrel and a shaft of the screw;

(c) a zone comprising a screw path of uniform pitch and having a diameter which results in a decompression or expansion of the material, and including one or more openings in the barrel for the escape of steam or vapour.

In order superficially to compress and to cool the extruded material, a platen press having cooled plates and adapted to reciprocate together with and back along the extruded material is conveniently used. It has been found that normal calender presses do not provide the desired effect because these presses exert the force at locations such that the structure is affected in an undesirable manner.

The covered material produced by the present method has a core comprising a thermoplastically fused mixture of finely divided wood and plastics material consisting of from 50 to 90 percent by weight of wood and from 50 to 10 percent by weight of plastics material, said core material being optionally provided with a covering of plastics material having the same or a similar constitution as the plastics of the core material, the interface between the covering and the core material being fused. This fusion eliminates the need for an adhesive bond between the core and the covering and can be made more uniform than an adhesive bond. Also because of such fusion the material is well suited to be sawn and nailed.

In one preferred embodiment, the core material comprises rigid PVC and the core is covered with soft or plasticised PVC.

The products which may be formed from the present material include skirtings and sills. Such skirtings or sills may have a smooth surface on one side thereof and may be provided with ribs on the opposite side which is later directed towards the centre of the room, with the whole assembly being provided with a covering about 0.5 millimetre thick. At the upper and lower edges, such a sill may terminate in a lip which, in the installed condition, abuts either the floor or the wall.

Furthermore, the following products may be produced by the present method and apparatus:

(a) a coated product having a core consisting of a thermoplastically fused mixture of finely divided wood and plastics material, the quantity of the wood ranging from 50 to 90 percent by weight and the quantity of the plastics material being within the range of from 50 to 10 percent by weight, a coating of a rigid PVC film, and a thermoplastic adhesive layer interposed between the film and the core. Surprisingly, it has been found that the thermoplastic adhesive layer is substantially completely absorbed by the surface of the product, so that no bubbles or blisters are formed.

(b) A sill or a decorative bar the structure of which corresponds to that of the product according to (a) and which is provided with a continuous profiling.

In order to enable the invention to be more readily understood, reference will now be made to the accompanying drawings, which illustrate diagrammatically and by way of example some embodiments thereof, and in which:—

Figure 1 is a schematic sectional view of apparatus for carrying out the present method,

Figure 2 is a schematic sectional view of a modification of the apparatus shown in Figure 1,

Figure 3 is a perspective view of a movable press,

Figure 4 is a perspective view of a piece of coated product, and

Figure 5 is a sectional view of a covered product.

Referring now to Figure 1, there is shown apparatus for producing a material in accordance with the invention. The apparatus comprises a pair of supply hoppers 1 and 2 for finely divided PVC and wood, respectively. The supplied quantities of the components of the mixture are exactly metered by a pair of gates 3 and pass through a predrier 4 into a mechanical mixer 5 comprising a cylinder having baffles protruding from the cylinder walls, whereupon the components enter the inlet of an extruder screw barrel 7. The extruder screw 8 which is rotatably mounted in the barrel, is driven by an electric motor 9 in conventional manner.

The extruder barrel 7 is adapted to be heated and vented. The material received by the screw is rapidly heated in an initial stage of the extrusion process to a temperature of about 200°C., a heating rate of about 100°C. per minute being expedient. This rapid heating of the mixed material serves to prevent some of the PVC within the mixture from not being subjected to the heating since the wood represents a very poor conductor of heat. The temperature, once obtained, is maintained throughout the length of the screw and is kept at a predetermined value by means of fans 11 and 12.

Thermocouples are installed at several places along the barrel for measuring the temperature and serve to effect control of the heaters and of the fans. The extruder screw 8 comprises at the initial portion thereof a double lead screw which, as shown, is so constructed that the volume between successive pitches decreases in the direction of travel of the material, whereby the product introduced into the screw is progressively compressed in the direction of conveyance. The initial portion is followed, i.e. after a length equal to about 26 diameters, by a portion without any screw lead (high compression zone 14) wherein the material is subjected to a particularly high compression. This is followed by a portion

provided with a screw 15 which screw has a capacity or receiving volume exceeding that of the zone 14. Accordingly, the material is decompressed in the region of the screw 15, whereby the vapours which hav formed during the compression path in the region of the screw 8 by the heating of the wood, are released through the structure of the product. In this region, the barrel is formed with apertures 16 to which are connected pipes 17 in which a reduced pressure is produced by a suction device 18. In view of the fact that large quantities of condensed water appear in the pipes leading to the suction device 18, there is further provided a steam or vapour separator 19 (schematically shown) by means of which the condensed water may be removed.

Accordingly, the mixture is first heated within the extruder casing 7, then compressed until a maximum value of compression is reached, thereafter allowed to expand and subjected to a reduced pressure of about from −0.5 to −0.9 kp./cm.². In view of the fact that the steam or vapour produced is enclosed within the material during the complete mixing step in the screw, the risk of carbonizing the wood is avoided. By varying the vacuum, the consistency of the material may be varied in its structure depending upon the wood or plastics material employed, the degree of moisture, the grain size, etc. In principle, it can be assumed that a higher degasifying and, thus, a higher density of the material are obtained at a higher vacuum.

Following the decompression or expansion path (screwthread 15), the material passes to an extruding die 20 which is heated and which operates at a temperature of about 180°C. The die 20 is formed with a relatively small orifice conforming to the desired cross-section of the extruded material, and it releases the heated extruded material or extrusion 21 to the free atmosphere. From this point, the extrusion is drawn through further parts of the apparatus by means of drawing rolls 37.

The extrusion is transferred from the die 20 into a platen press 22 in which the extrusion is pressed in discrete lengths and simultaneously cooled.

Figure 3 shows the details of the press. The press 22 comprises a carriage 23 mounted on rails, and movable forth and back by means of a cable assembly 24. The carriage 23 includes a lower platen 25 and a movable upper platen 26. The upper platen 26 may be pressed against the lower platen by means of a pair of cylinders 27 which are located on a stationary surface. Both platens have cooling passages extending therethrough and are supplied with a cooling medium from the exterior through flexible cooling conduits (not shown) fitted to inlets 28.

The cables of the cable assembly 24 which are passed to a position closely downstream of the mouth of the extruding die 20, serve both from drawing and as a support for the approaching extrusion 21.

For the pressing operation, the press 22 is moved into a position closely adjacent the extruding die 20 so as to accommodate the extrusion 21 between the opened platens 25 and 26 shortly downstream of the mouth, and so as to compress the extrusion with a force of about 4 kp./cm.² when the platens are closed, the press being then moved along with the withdrawn extrusion. In a predetermined position, the platens are opened, the pressing tool 22, drawn by the cable assembly, is returned to a position in front of the extruding die, the platens are closed, and the pressing operation is repeated. This ensures a particularly uniform compression of the extrusion, and the extrusion travels in the atmospheric air so that further quantities of steam or vapour may be released. Furthermore, the platens of the press are cooled so that further cooling and, thus, solidification of the extrusion are obtained immediately upon its exit from die.

For further cooling and drying of the extrusion, it is additionally passed through one or more vented chambers 30 through which air is blown. Then, the extrusion 21 is introduced into a heatable covering die 31, which has laterally connected thereto another extruder 32 which is supplied e.g. with flexible PVC through a hopper 33. The PVC enters the covering die through a slot-shaped orifice and is pressed around the entering extrusion 21 in conventional manner.

The covered extrusion 35 is again cooled within vented chambers 36 and then moves to the drawing rolls 37. Immediately after its exit from the die 20, the tensile strength of the extrusion is so high that the extrusion may be readily withdrawn with a great force. Downstream of the drawing rolls 37, there are provided cooling devices, cutting devices and the like, by means of which the covered extrusion may be cut to sections of predetermined length.

In order to further explain the method, a specific example of the method is given below: Beech-wood having a grain size of 3 mm. is used as the finely divided wood and rigid PVC having a Shore hardness of from 50 to 97 is employed as the plastics material. The wood and plastics material are used in a ratio of 68% of wood and 32% of PVC. Subsequently, the mixture is heated to a temperature of 190°C. and received by the screw of the extruder. A double lead screw having a length equal to 36 diameters is used, which screw after an

extent of 26 diameters has a high compression zone of 2.8 diameters length. The degasifying and decompression or expansion are effected by a screw having a length equal to 30 diameters, a reduced pressure of −0.7 kp./cm.^{2} being applied. The temperature within the die is about 170°C. in the case of the production of a skirting board core. The processing within the die 31 and the covering with soft PVC are performed in a temperature of about 170°C.

If the product is to be provided with a coating, the arrangement according to Figure 2 may be used. As can be seen from Fig. 2, a feed device for a coating film 50 is located adjacent the outlet opening of the die 20. A supply of the film is wound upon a supply coil 51, and the film is passed from the supply coil via guiding and stretching rollers 52 to a deflecting and stretching roller 53 which is cooled.

The coating film 50 is originally provided with a coating of a thermoplastic adhesive and the face carrying the adhesive is pressed onto the hot surface of the extrusion 21 by the deflecting roller 53. The adhesive melts due to the internal heat of the extrusion, and the film is bonded to the upper surface of the extrusion. The deflecting roller 53 is cooled in order to prevent the film from becoming too hot.

From the deflecting roller, the extrusion is passed into a platen press 22 (as described with reference to Figure 1) where the film is pressed onto the extrusion, and the thermoplastic adhesive is absorbed by the porous surface of the extrusion. The platen press 22 is also used because this press is particularly useful for impressing a pattern into the coated extrusion.

A die 55 (Fig. 3) may be mounted below the upper movable platen 26, which die has a patterned structure in the underside thereof. By means of the die, a pattern 56 may be impressed into the surface of the coated extrusion 21 each time the platen 26 is lowered towards the surface of the extrusion. By correspondingly marking and controlling the extrusion, the latter may be provided with an exactly repeating pattern. For example, it is also possible to perform the series production of reference signs provided with letters, which signs need only be severed to form sections after the passage of the extrusion through a cutting machine.

For further cooling and drying the extrusion, it is additionally drawn through one or more vented chambers 30 through which air is blown. At the end of the processing operation, the extrusion is led through a plurality of drawing rolls 37, whereupon it is severed into sections by conventional cutting tools (not illustrated).

Figure 4 is a perspective view of an extrusion 57 coated with a film which has a pattern 56 impressed into its surface. The core of the extrusion, and thus the main body, consists of a mixture of wood and PVC which have been intimately mixed and fused with each other. A covering or coating film 50 is adhered to the core. The adhesive layer disposed between the core and the film has been absorbed by the finely porous upper layer of the core so that it is hardly possible in the finished product to recognize and adhesive layer between the film and the core.

Figure 5 is a cross-sectional view of a covered extrusion 35 which is formed as a floor skirting. The core of the extrusion 35 comprises a material made of wood and PVC which have been intimately mixed and bonded with each other. The core is surrounded by a covering 41. The interfaces between the core and the covering are bonded to each other. The covering consists of soft PVC, whereas rigid PVC has been used as a compartment of the core. Further, the covering includes a pair of lug-shaped extensions 42 and 43. One of these extensions is intended to abut the wall and the other extension conforms itself to the floor when the extrusion is installed as a floor skirting.

Of course, many other types of bars or boards may be formed form the above-described product having a coating or a covering, such as e.g. boards for plastics material window frames, for ornaments of furniture, for guide bars and the like.

WHAT I CLAIM IS:—

1. A method of producing a shaped material made of wood and a thermoplastic plastics, wherein a mixture of finely divided wood having an average particle size of not more than 3 mm. and finely divided thermoplastic plastics material having an average particle size of from 0.02 to 10 mm., in a ratio of from 50 to 90 percent by weight of wood and from 50 to 10 percent by weight of plastics material is heated up to a temperature at which the plastics material is present in a plastic to highly viscous stat , the mixture then being subjected to compression followed by decompression or expansion, with removal, at least during the decompression phase, of a gas-water mixture evolved as a result of the heating of the wood, and wherein the mixture of wood and plastics is then introduced into an extrusion die and extruded.

2. A method as claimed in Claim 1, wherein the thermoplastic plastics is a finely divided rigid polyvinyl chloride.

3. A method as claimed in Claim 2, wherein the mixture comprises 60 percent by weight of wood and 40 percent by weight of PVC.

4. A method as claimed in any one of

Claims 1 to 3, wherein the wood is in the form of chips having a particle size of from 0.05 to 3 mm.

5. A method as claimed in any one of Claims 1 to 4, wherein the wood is pre-dried beech-wood.

6. A method as claimed in any one of Claims 1 to 5, wherein the mixture is rapidly heated at a rate of substantially 100°C. per minute to a temperature of 190°C. ± 20°C., and wherein this temperature is maintained substantially constant up to the extrusion die.

7. A method as claimed in any one of Claims 1 to 6, wherein the heated mixture is subjected to compression and then to decompression or expansion with simultaneous application of a vacuum or reduced pressure to remove said gas-water mixture, whereafter the material passes into the extrusion die.

8. A method as claimed in Claim 7, wherein the reduced pressure is of from −0.5 to −0.9 kp./cm.².

9. A method as claimed in any one of Claims 1 to 8, wherein the extruded material issuing from the extrusion die is pressed in discrete lengths in the free atmosphere, whereby the pressed surfaces are cooled.

10. A method as claimed in any one of Claims 1 to 9, wherein the extruded material is covered by drawing the material through a heated chamber to which a thermoplastic plastics similar to that used to form the original mixture is pressure fed so as to mould and fuse a cover layer around the extruded material within the chamber.

11. A method as claimed in any one of Claims 1 to 9, wherein the heated extruded material which leaves the extrusion die is coated with a thermoplastic adhesive, and wherein a coating film is subsequently pressed onto the material and bonded thereto.

12. A method as claimed in any one of Claims 1 to 9, wherein a film which is already coated with a thermoplastic adhesive is fed into contact with the heated extruded material leaving the extrusion die and the film is then pressed onto the material and bonded thereto.

13. A method as claimed in Claim 11 or 12, wherein the coated material is provided with a pattern during the pressing step and/or during an additional passage through a press.

14. A method of producing a shaped material made of wood and a thermoplastic plastics substantially as hereinbefore described with reference to Figs. 1 and 3 to 5 or 2 and 3 to 5 of the accompanying drawings.

15. Apparatus for producing a shaped material made of wood and a thermoplastic plastics, comprising a screw-type extruder and means for heating it, the screw-type extruder having a barrel within which is located a screw providing at least the following zones, as seen in the intended direction of travel of material therethrough:

(a) a zone comprising a dual lead screw, the volume between successive pitches of which decreases in said direction;

(b) a zone comprising a shaft portion without any screw leads, but having such a diameter that material pressed by the upstream leads is compressed between the inside of the barrel and a shaft of the screw;

(c) a zone comprising a screw path of uniform pitch and having a diameter which results in a decompression or expansion of the material, and including one or more openings in the barrel for the escape of steam or vapour.

16. Apparatus as claimed in Claim 15, and further comprising a platen press having platens which are adapted to be cooled and adapted to be moved forth together with and back along the material extruded from said extruder to press the material.

17. Apparatus as claimed in Claim 15 or 16, and further comprising means for pressure feeding a thermoplastic plastics around the extruded material.

18. Apparatus as claimed in Claim 15, and further comprising means for feeding a film coated with a thermoplastic adhesive into contact with the extruded material, and a platen press adapted to be moved forth together with and back along the extruded material, and including a cooled press platen arranged above the side of the material onto which the film is to be contacted and provided with a die.

19. Apparatus for producing a shaped material made of wood and a thermoplastic plastics substantially as hereinbefore described with reference to Figs. 1 and 3 or 2 and 3 of the accompanying drawings.

20. A shaped material made of wood and a thermoplastic plastics produced by the method claimed in any one of Claims 1 to 14 or by the apparatus claimed in any one of Claims 15 to 19.

21. A covered extrusion of material produced by the method claimed in Claim 10, wherein the material comprises a core of a thermoplastically fused mixture of finely divided wood and plastics consisting of from 50 to 90 percent by weight of wood and from 50 to 10 percent by weight of plastics, said core being enclosed by a covering.

22. A coated material produced by the method claimed in Claim 11 or 12, wherein the material comprises a core of a thermoplastically fused mixture of finely divided

wood and plastics containing from 50 to 90 percent by weight of wood and from 50 to 10 percent by weight of plastics, and a coating in the form of a rigid PVC film, the bond between the film and the core being formed by a thermoplastic adhesive,

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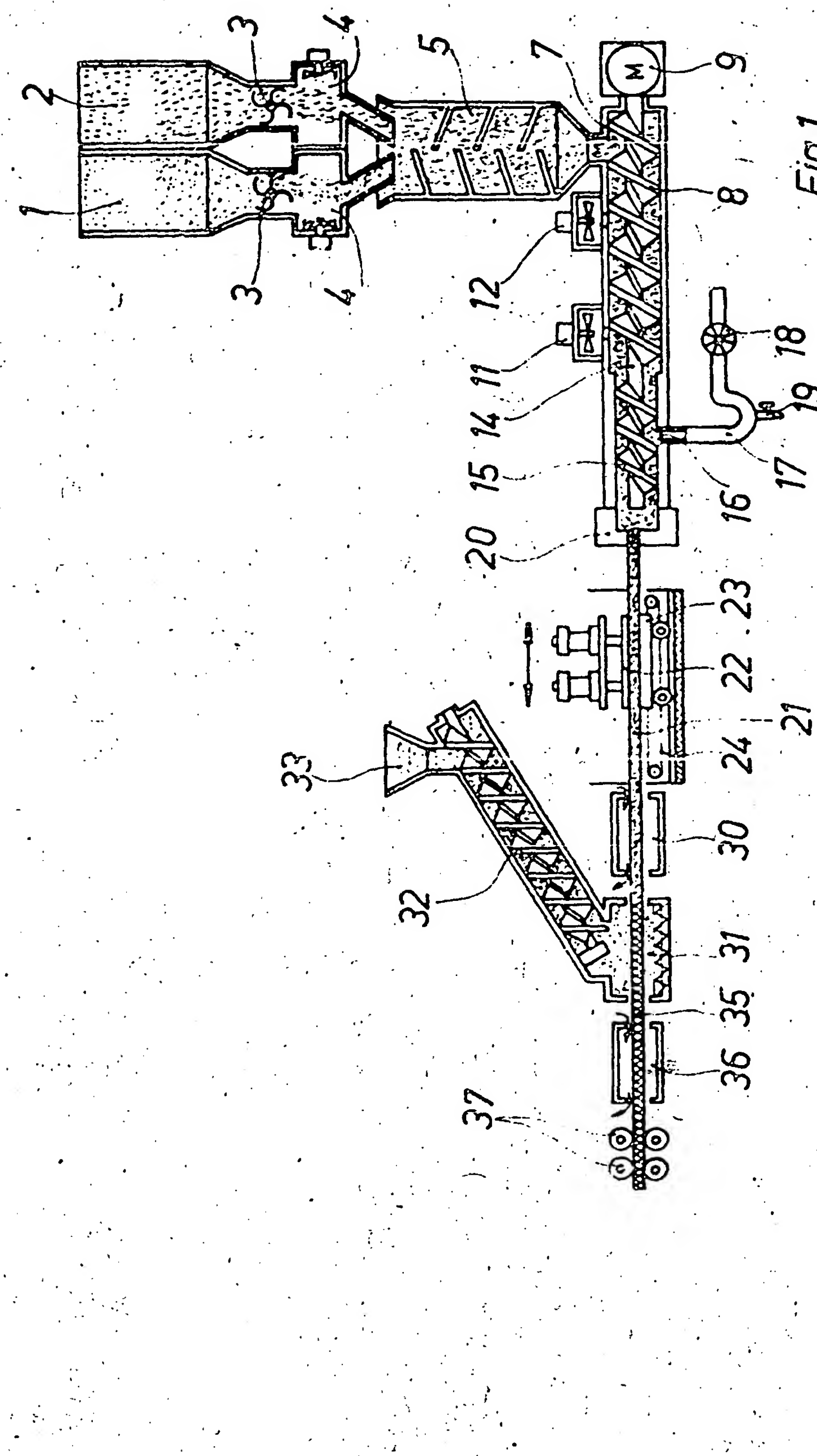
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Fig.1

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Sheet 2

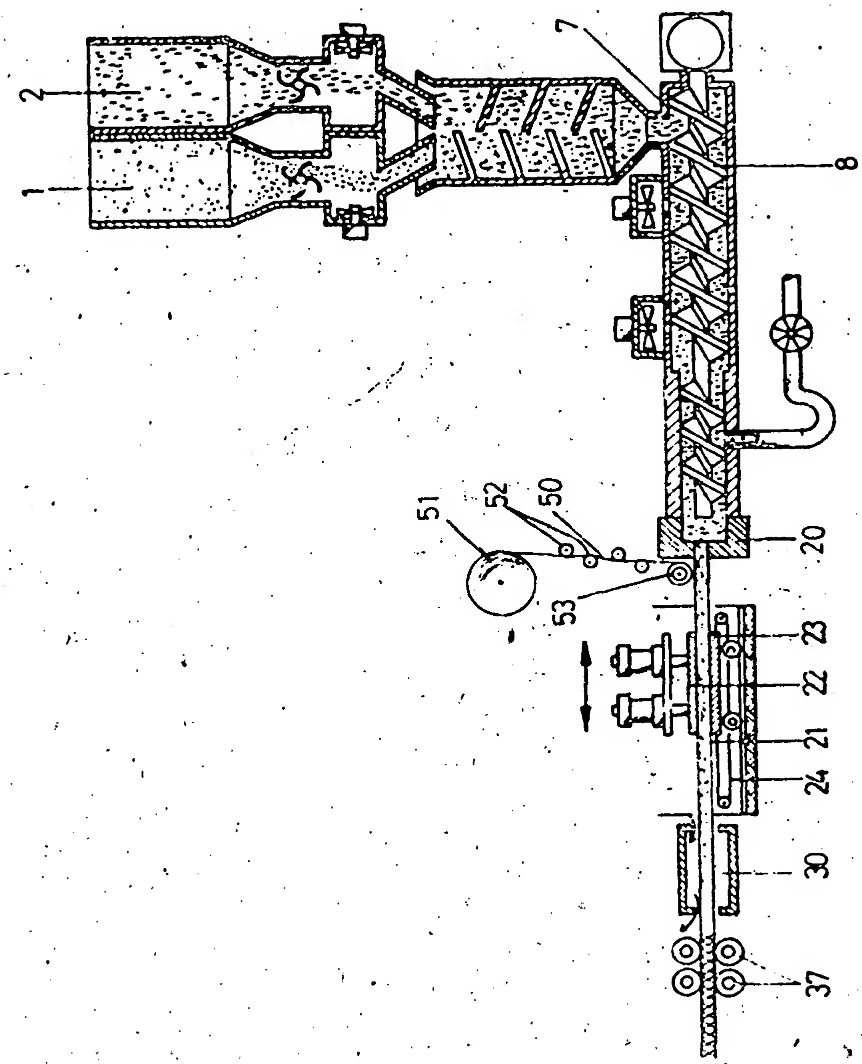

Fig.2

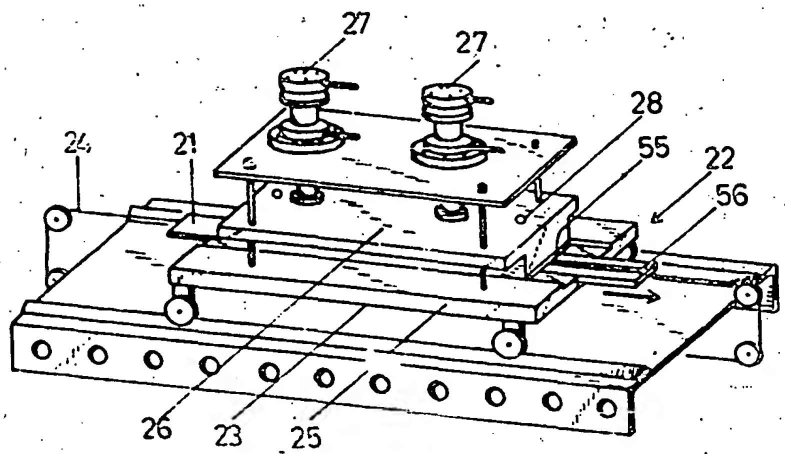

Fig. 3

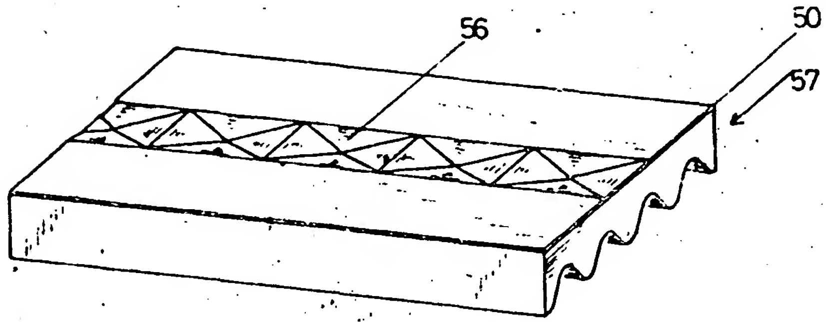

Fig. 4

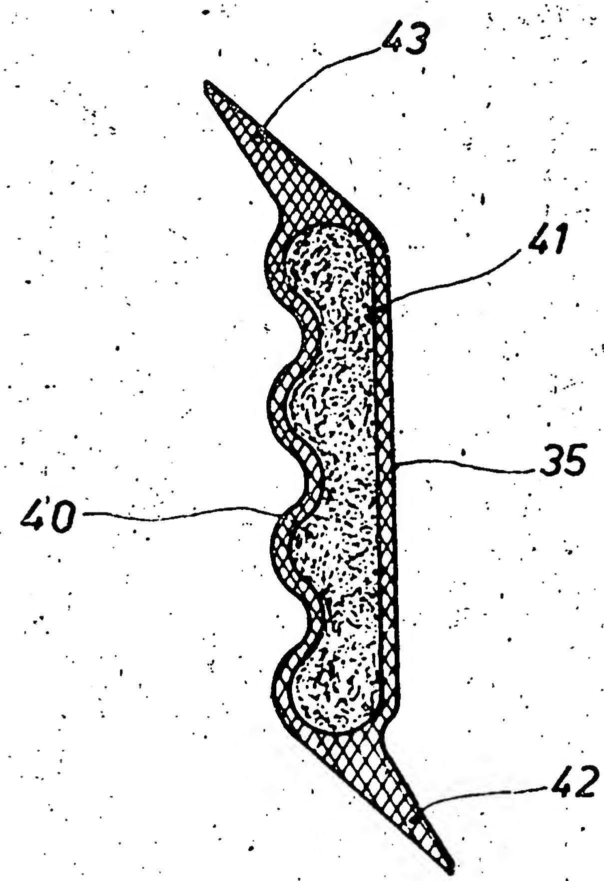

Fig.5